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ABSTRACT

Proceedings of the North Country Workshop on Science, Technology, and the Undergraduate Curriculum are presented. The Sloan Foundation's call for reform of the liberal arts and coverage of mathematics, science, and technology is noted in welcoming remarks by State University of New York, Potsdam, President Humphrey Tonkin. Stephen H. Cutcliffe considers the development of the science, technology, and society (STS) field and recent interest in scientific and technological literacy in "Science, Technology and the Undergraduate Curriculum: Where Are We Nationally?" Curricular goals and ways to achieve them are also addressed, and a list of journals (and addresses) on STS topics is provided. In "Scientism and the New Liberal Arts," Richard H. Robbins explores the implications of scientism for both public policy and the U.S. value system, and the relationship between science and technology encompassed by the new liberal arts. Neal R. O'Brien describes an interdisciplinary course covering key scientific issues in "A Discussion of the Science in Society Course at Potsdam College." Finally, Robert Keesey's paper covers "The School-Within-the-School Program of the State University College of New York at Potsdam: An Experimental, Interdisciplinary, General Education Core." A syllabus and required reading list for the 20 semester-hour freshman core are included. (SW)

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FOUNDERS' WEEKEND

North Country Workshop on
Science, Technology and the Undergraduate Curriculum

Proceedings

November 9 and 10, 1984

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NEW LIBERAL ARTS NEWSLETTER
Vol. 1, No. 1, September 1985

The attached **Proceedings** of the November 1984 North Country Workshop on Science, Technology and the Undergraduate Curriculum constitute the first **New Liberal Arts Newsletter** from the State University College of Arts and Science at Potsdam, New York.

Since the June, 1984 New Liberal Arts Colloquium at Albany, there also have been conferences at Fredonia and Cortland, and forthcoming ones at Buffalo and Brockport, addressing the issues surrounding the incorporation of more science and technology in the general curriculum. Because there is now a growing interest about "what kinds" of courses and programs compose the new liberal arts, and "how" such courses might be implemented, SUNY Potsdam has agreed to serve as a statewide clearinghouse for this kind of information by publishing an irregular and simply-duplicated newsletter.

We would like to receive any program or course descriptions, syllabi, and rationales that you feel incorporate or support science and technology in the general curriculum. We will, in turn, organize and duplicate these, add what knowledge we glean about upcoming conferences or events of interest, and send this information out to all the SUNY units under the title, **New Liberal Arts Newsletter**. Since we will only publish when we have sufficient materials, please inform all interested colleagues and keep the information coming.

Send materials and announcements to:

New Liberal Arts Newsletter
Office of the Dean of Liberal Studies
State University College of Arts and Science
Potsdam, New York 13676

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Attachment

26 September 1985

Proceedings of the North Country Workshop on Science, Technology and the Undergraduate Curriculum.

Held at SUNY Potsdam, November 9 and 10, 1985

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NORTH COUNTRY WORKSHOP ON SCIENCE, TECHNOLOGY AND THE UNDERGRADUATE CURRICULUM

Welcoming Remarks

It gives me great pleasure to welcome you to this North Country Workshop on Science, Technology and the Undergraduate Curriculum. This meeting is an outgrowth of an earlier conference held in Albany in June. This earlier, statewide conference of the State University of New York was sponsored by the Sloan Foundation, which has for some time now been interested in the question of the reform and redirection of the liberal arts. Specifically, the Sloan Foundation is interested in what it describes as the New Liberal Arts: new techniques and new subject areas that it considers an integral part of a modern approach to liberal education.

The American collegiate ideal of the liberal arts has always viewed the general education of undergraduates as embracing four elements above all: first, an introduction to high culture- the arts, the forms of expression held in highest regard by the makers of taste in our society, and some awareness of the symbol systems of other societies; second, the modes of thought and the methodologies associated with the various disciplines, as these have been developed in our society primarily in the nineteenth and early twentieth centuries; third, knowledge of the world - an acquaintance with the environment, social and physical, in which humanity finds itself; and, fourth, the techniques of learning - the devices that allow us to manipulate our own symbol systems successfully, among them an ability to write well, an ability to use foreign languages, and a familiarity with mathematical

and logical symbol systems. Inherent in this idea of the liberal arts is, of course, an awareness of the past: the historical dimension is an essential part of all four of the areas that I have mentioned.

In recent years, some of our perceptions about the world and about education have changed. We are ambivalent about the notion of high culture, many of us believing that the very existence of such symbol systems in combination with economic power excludes a large part of the population. Is education a process of socialization into the elite or is it some other thing? To what extent is it important, as a part of a liberal education, to understand popular culture as well as high culture, the art of the street as well as the art of the gallery?

We also have a certain ambivalence about the traditional configuration of the disciplines. Are they a consequence of a logical compartmentalization of a finite number of phènomena or are they the relatively arbitrary consequence of the establishment of academic guilds of like-minded people with the budgetary power to establish themselves in the major research universities? The truth obviously lies somewhere between the two, but even that realization may cause us to question the immutability of disciplinary organization.

Knowledge of the world has, of course, changed in fundamental ways as well. The rise of new nations, the expansion of communications to cover the globe, the increasing integration of our economies with those of other countries - all these have led to an awareness of pluralism and diversity that threatens our hold on what might be described as the western tradition. At the very least, we are obliged to see this western tradition and its influence in a larger context and to reexamine or expand some of our traditional values to embrace diversity.

Finally, the techniques of learning have expanded and changed in recent years. Some of the traditional techniques, such as good writing,

good speaking and a knowledge of foreign languages, have lost much of their ground. Indeed, today we see a concerted effort to bring them back into the curriculum and accord them a more dominant position. Other techniques, particularly those derived from mathematics and the natural sciences, even though they might be regarded as fundamental to modern patterns of thinking, have hardly penetrated our idea of the liberal arts at all. It is at least arguable that all students today should have an acquaintance with the techniques of mathematical modeling, not because they can be regarded as the be-all and the end-all of scientific or social scientific reasoning, but because they are a fundamental part of so much of modern scientific decision-making and planning that we need to know their advantages and limitations. I might add that, both with respect to the techniques of learning and with respect to knowledge of the world, so great have been the advances in technology and science in recent years that the very data available to us about the world and our own society have changed and multiplied fundamentally.

These major changes in our society and our perceptions, coupled with a massive democratization of higher education over the past generation or two, might be construed as threatening the liberal arts. I would argue, however, that this is not entirely the case. Threatened, certainly, are the programs in the liberal arts at many colleges around the country because these programs have not changed or adapted themselves to fit changed circumstances. It is not the liberal arts that are at fault, but the content of our liberal arts programs. We must continue to teach our students about our cultural and political values and those of other societies; we must continue to acquaint them with the modes of thought of the various disciplines and with the configuration and sociology of knowledge. We must provide them with a

knowledge of our world, as we seek it today and as others have seen it in the past. We must provide them with a full range of the techniques of learning available to modern society. But in doing these things we must take into consideration the tension between egalitarianism and socialization, the way in which modes of thought and disciplinary approaches to knowledge change over time, changed perceptions of the world and of natural phenomena, and, finally, the numerous new ways and techniques of learning which coexist, or can be made to coexist, with more traditional techniques.

So the Sloan Foundation's call for an examination of the New Liberal Arts is in effect an admission that programs in the liberal arts have lost something of their focus and (if I dare use such a word) their relevance to the realities of modern society. It is not so much that we need to throw away the old as that we need to examine the traditional and bring it into harmony with the new. We are concerned, in short, with broadening the territory of the liberal arts while maintaining the integrity of the tradition.

In effect, there have been three responses to the Sloan Foundation's call. First, there are those who maintain that particularly the techniques of mathematics, as these are applied in many other disciplines, should be a fundamental part of liberal learning. I am not convinced that we have given enough attention to this aspect of the subject, except insofar as it bears on computers, which are increasingly receiving the attention of people outside the sciences. Second, there are those who stress the fact that modern technology has simply changed the shape of society in fundamental ways. These people argue that we need to understand more about the techniques of modern communication, advances in medicine, progress in the sciences, and so on. Third, there are those who suggest that mere knowledge of these new

fields is not enough, but that the fundamental question that must be addressed is how science and technology have made imperative the development of new ethical systems, a new morality, without which we shall be unable to build the social and cultural institutions required to preserve and enhance the freedom of the individual and the prosperity of the collective.

I hope that in the discussions of the next day or so we shall not loose sight of the depth and range of our topic and that we shall also ask ourselves repeatedly not how one definition of the liberal arts can replace another but how the one can be brought into harmony with the other. It is not that we should throw away what we have learned but that we should make the liberal arts once again the cornerstone of education.

On a more mundane level, I hope that the next day will show us the way to cooperate more extensively among our various institutions to expand and develop our liberal arts programs to embrace some of the subject matter that we shall be concerned with in our workshop here. I am a strong believer in the value of such cooperation and I hope that, as unfortunately happens so frequently on such occasions, we shall not go away from here with mere pious hopes but with specific and concrete mechanisms for contact and cooperation and clear assignment of responsibilities. I am sure that our discussions will be crowned with success.

Humphrey Tonkin
President

HT/ps

Science, Technology and the Undergraduate Curriculum - Where Are We Nationally?*

Stephen H. Cutcliffe

The title of my talk this evening, "Science, Technology and the Undergraduate Curriculum - Where Are We Nationally?", is I suppose, one of those catch-all titles agreed upon in the first flush of enthusiasm after having agreed to speak at a conference several months in advance, when you have only a vague notion of what it is you will actually say on the appointed day. As I now see my task, however, it has three parts. First, by way of background I would like to take a few moments to describe both the development of the science, technology and society field, or STS as it has come to be known, and the more recent interest in "scientific and technological literacy" about which we have been all hearing so much of late. I should note that I am not terribly comfortable with the term "technological literacy," but at the moment no better term seems to have emerged. Second, and perhaps most important, I would like to try to describe what I see as the most important curricular goals in these areas and to suggest some approaches for hopefully attaining those goals. And here I will perhaps speak more about technology studies than about science because it is an area I am more familiar with, although I believe most everything I am going to say

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* Some of the ideas and parts of this paper have appeared in revised format in "STS, Technology, and the Arts Curriculum," Bulletin of Science, Technology and Society 2 (1982):291-307 and "Science, Technology and the Liberal Arts: Report on a National Conference Held at Lehigh University," Science, Technology and Human Values (forthcoming) both co-authored with Steven L. Goldman.

about technology can also be said about science. More important, however, is the fact that it is the technological realm that most of us experience first hand and must deal with on a daily basis. And finally, by way of example, I would like very briefly to describe some programs which I believe to be on the right track toward attaining at least some of those goals. In tomorrow afternoon's panel session, I will review some specific resources that are currently available but with which some of you may be unfamiliar.

Now, what is this STS and technology literacy stuff all about, and how did we get to where we are today? Science, technology, and society studies, or STS as I will refer to it, is precisely what it says -- the study of the interactions of science, technology and society, including both the role of science and technology in shaping contemporary society and the role of cultural values and societal institutions in molding the very nature of our scientific and technological endeavors. On the surface of things, this may seem very obvious, but the development of this field as a conscious academic discipline is really only about 10-15 years old.

When I first started working for our STS Program some years ago, it had the somewhat curious name of Humanities Perspectives on Technology or HPT for short. Once when we called our university dining services to reserve a room for some function, Mrs. Bird, a delightfully out-of-touch woman in charge of such matters, after we told her what group it was for said, in her inimitable fashion, "What's this HPT, some kind of gasoline?" For a long time after we changed the name of the program, the recognition factor of STS was not much better. Most people looked

at me somewhat strangely thinking I worked for SDS. Today, however, there are very few people, at least in academic circles, who would mistake STS for a gasoline additive or Students for a Democratic Society.

STS got its start in post-WW II society, but it has been only in the last fifteen years or so that we have really become increasingly aware of the relationship of science and technology to society and of the need for a clearer understanding of STS issues. Widely read authors such as Rachel Carson in Silent Spring, Jacques Ellul in The Technological Society, Theodore Roszak in The Making of a Counter Culture and Where the Wasteland Ends, and Alvin Toffler in Future Shock and The Third Wave and such recent events as the energy crisis, Three Mile Island, acid rain, and the fear of nuclear conflict have all brought to the public's attention the potentially devastating impact of technology upon society. No longer are science and technology viewed solely as forces of "good". Reactions have ranged from indifference to outrage to sophisticated analysis. This last reaction, an increasing professional interest in the interactions among science, technology and society has come to define, albeit loosely, the STS field. Involvement with STS concerns takes place in a number of different sectors -- industrial, governmental, academic-- but in the academic world alone, there are now over 100 formal programs and many more informal groups of courses serving a variety of STS needs. This quickened interest reflects an awareness of the increasingly technological nature of modern industrial and post-industrial society and the need to better understand technology if we wish to have our technology serve us positively rather than dominate us problematically.

Now, let me digress for just a moment from this mini-history to say something about what science and technology are. Science is perhaps somewhat easier to understand. Briefly put it is concerned with natural phenomena and attempts to provide a coherent account of physical and biological objects and events through observation and experiment. Defining technology, however, is a little trickier. While we all know, or think we know, what we mean by "technology", it is much more difficult to sit down and write a simple definition that will be acceptable to most, let alone all, scholarly disciplines, times and places. Nonetheless, some common understanding <u>is</u> necessary. Thus, I would like to suggest that we look at technology, not solely in the sense of humanly created artifacts, techniques, or systems based on accumulated knowledge, that are designed to modify the environment to serve human needs (which definition seems I think to capture the essence of most of the better attempts at defining technology), but rather that we view technology as a <u>social process</u>. By this I mean that what we usually mean by technology is really technological development. It is a product of social processes in which abstract economic, cultural, and social values shape, develop, and implement specific artifacts and techniques through such prevailing institutions as business, government, and the marketplace. Thus, technology is different from engineering, a term which refers to the specific activity which generates particular artifacts and techniques. It is also much more than applied science, although it certainly draws upon scientific knowledge and methodology. If we accept this definition, which suggests that technology is inherently value laden, it should be clear that the public has an important responsibility for its technology because of its intimate involvement with it through its institutions and value-based decisions. To carry out that responsibility, however, requires a better

understanding of the social process of technology and, as a result, we have seen among other things the rapid spread of STS courses, as I have noted.

Because of technology's importance and its value-laden nature, the public is increasingly called upon to make decisions in one form or another regarding technical issues covering a wide range of areas and fields - for example, questions regarding economic stability, nuclear technology, industrial pollution, worker health, computerized data banks, computer-aided manufacturing, medical techniques, or safety regulations in any number of fields. Such decisions require a technological understanding not presently held by most college-trained citizens, let alone by those who have never attended college nor taken an STS course.

All this concern has led to the call for and an intense campaign on behalf of scientific and technology "literacy" for arts students. The opening salvo in this newest "literacy" campaign would appear to have come from a group of prominent engineering educators, who five years ago formed the Council for the Understanding of Technology in Human Affairs (CUTHA). CUTHA's announced purpose was to promote the study of technology by college students not majoring in science or engineering. They have since sponsored a number of conferences at which science, humanities, and engineering faculty from a variety of colleges and universities have tried to articulate what it is about technology that they feel arts students need to know and how to teach it. CUTHA has matured as an organization over the course of the past several years, and it now publishes its own newsletter called the Weaver and is receiving recognition from major corporations, foundations, and government, and academic groups as an interested party in the campaign for technology literacy.

In spite of this maturation, however, it seems likely that the intense media coverage currently being given to technology literacy is attributable not to CUTHA's steady efforts in academic circles, but to recent heavy public and political promotion of this cause by such groups as the Sloan Foundation, the Carnegie Institute for Higher Education, the National Science Foundation, the National Research Council, the National Academy of Science, the American Association for the Advancement of Science, and most recently the Association of American Colleges, representing the special interests in curriculum development of its seven hundred arts college members.

The National Science Foundation, for example, in a 1980 report entitled Science and Engineering Education for the 1980's and Beyond noted that American high school and college graduates emerge with "only the most rudimentary notions of science, mathematics, and technology."

The National Research Council in a 1982 report called for an "understanding of science [on the part of the college educated public] that will prepare them to (1) seek reliable sources of information, (2) to look beyond the content of scientific claims to the care with which the scientist has framed the statement, and (3) to ask the right questions." This will allow people not trained in science, mathematics or engineering "to grasp [technical] information, examine it, evaluate it for soundness, and apply it appropriately."

For its part, the Sloan Foundation entered the fray in 1981 by way of a staff-generated booklet, The New Liberal Arts, calling for introducing into the arts curriculum courses that would give arts students a substantial introduction to mathematics, science, and technology. After wide distribution of this booklet and after co-sponsoring a number of relevant conferences, Sloan announced a multi-

million dollar program of support for arts colleges willing to incorporate "quantitative skills" and "technological modes of thought" into their curricula. Subsequently a small number of "elite" liberal arts colleges received awards for faculty training and the development of model programs. This program is now in its second year and most of the schools that I am familiar with are holding faculty development seminars and organizing conferences on technology-related topics. Course development at most of these colleges has just begun, so it is not possible for me to describe projects in detail or to anticipate with any confidence their future success, although the most recent issue of the Weaver does include descriptions of several courses developed under Sloan auspices.

Other reports and studies similarly recognized the problem and called for more effective solutions. The National Science Board's Commission on Pre-College Education in Mathematics, Science, and Technology published two reports entitled Today's Problems, Tomorrow's Crises and Educating Americans for the 21st Century, while the National Commission on Excellence in Education followed with A Nation at Risk, and the Carnegie Foundation came out with High School: A Report on Secondary Education in America. Numerous editorials in both the popular press and in a variety of academic and professional journals have echoed the call as well, one of the most recent being Edward A. Knapp's guest comment in the July issue of Physics Today. Knapp, who is director of the National Science Foundation, called for a broad education, including science and technology, for Americans who are about to enter the 21st century. He argued that "the sciences and the humanities represent distinct, [but] complementary modes of thought."

In retrospect, then, one can see a steady and rapid development during the past five years which has centered on calls for significant modifications to existing elementary, high school, and college curricula on behalf of increasing competency levels in those quantitative and reasoning skills relevant to a wider public involvement with scientific research, applied science and engineering.

The motives underlying these calls are diverse. Some reflect the same sort of anxieties which pervaded the calls for educational reform following the launch of Sputnik in 1957. Some reflect concerns about the ability of the American public, in the absence of a deeper understanding of science and technology, to deal with the increasingly important roles in our society of science- and technology-related policy-making decisions. And some, no doubt, reflect concern about the adequacy of an educational system that does not equip students with the cognitive tools fundamental to coping with the social and economic forces that shape their physical, social, and political lives.

In the course of these five years of discussions, however, the definitions of "science literacy" and "technology literacy" have barely been specified. Nor has there emerged very much in the way of precise specification of how this literacy is enhanced by the liberal arts curriculum, apart from global proposals for improving the teaching of science and mathematics and imposing more stringent course and competency requirements at all levels. Finally, there has been little sign that activists on behalf of science and technology literacy appreciate the distinctive character of coursework in the humanities <u>vis-à-vis</u> coursework in science, mathematics, and engineering. The latter are offered to self-motivated students who must master course materials because they will be integrated sequentially into increasingly sophisticated, technical problem-solving skills they <u>need</u> to acquire.

Humanities courses, however, have a more diffuse and 'horizontal' character. They are keyed to the acquisition of interpretive skills rather than technical problem-solving skills. Insofar as humanities students are required to take science and mathematics courses, they generally lack interest and motivation, perhaps because they know that these materials will not be integrated into their subsequent learning experiences or professional activities. Ignoring these distinctions virtually guarantees that new science and technology literacy courses will not readily be assimilated into liberal arts curricula, even if the new courses are imposed as requirements.

I am committed to the view that such courses need to be based on the broad educational objectives of the liberal arts, rather than on the narrower instructional objectives of curricula for students majoring in mathematics, (physical) science, and engineering. Unfortunately, all too often, the current science and mathematics requirements for humanities and social science students impose on them "instructional" courses, in spite of the fact that this approach is universally acknowledged to have failed to achieve literacy in these subject areas.

I have some suggestions about what scientific and technological literacy should entail, but perhaps first I should tell you a short story which clarifies what technological "illiteracy" is. When President Reagan was being interviewed by the press just before taking office some 3-1/2 years ago, he responded to a question regarding energy needs by saying he was all in favor of solar energy. He outlined a special project he had in mind which entailed building a gigantic pipe line to the sun through which he was going to capture the sun's energy and ship it back to earth --for free of course, for we all know solar energy is free. The reporter interrupted the president and said "But, Mr. President, you know how hot the sun is, aren't you afraid the pipe

will melt?" Without batting an eyelash the President responded, "Oh, don't worry, I've got that problem all figured out, we're only going to operate at night."

Now, this story is obviously apocryphal. In fact, it comes from part of a Rich Little impersonation at a Reagan swearing in party almost four years, ago, but I think it does illustrate in a humorous way the need for scientific and technological understanding.

But what is it exactly that our students and we as citizens should understand about science and technology?, about that pipe line? I would suggest that there are really <u>two</u> elements. The first, as should be obvious from my previous analysis of technology as a social process and of the centrality of that process for our society, is the need to understand the social nature and context of technology and of course its relation to science. Here, I believe the many STS courses and programs to which I have alluded are doing a good job. Granted there are many things that could yet be done in terms of deepening our understanding and by expanding such awareness to other colleges and universities, but in the main, I believe we are on the right track here.

The second area involves an analysis of scientific and, more specifically engineering concepts and techniques. Although there is an overlap and some mixing of these two areas, as indeed you would expect given the definition of technology I have proposed, it is the latter -- i.e. the scientific and technological concepts and techniques-- that is usually referred to when talking about such "literacy". Taking educational rather than instructional goals as the objective, I would suggest at least three things that such courses ought to aim for. Students should become familiar with 1) scientific and technological reasoning, 2) with the major current concepts and methodologies in the disciplines they are studying, and 3) with design and modeling

strategies in those same disciplines. Such an understanding will not make a liberal arts student into a scientific or a technical expert in any field, let alone all fields. Indeed, we do not ask this of our professionally trained scientists and engineers, most of whom specialize in particular sub-disciplines and are frequently unknowledgeable, except in a general way, of fields outside their own. However, it may make him or her more aware of the complex social, economic, and political milieu that surrounds all scientific and technological decisionmaking.

Thus, I am suggesting a need for an understanding <u>about</u> science and technology as well as a need for an understanding <u>in</u> science and technology.

Thus, I am suggesting a need for an understanding <u>about</u> science and technology as well as a need for an understanding <u>in</u> science and technology.

Edward Knapp in the article to which I referred a few moments ago lists five basic areas or aspects of science and technology regarding which liberal arts students should be knowledgeable.

First and foremost, all undergraduates should understand the basis of the scientific mode of thought --hypothesis and experimentation.

Second, they should understand both the distinctions and the synergistic relationships between science and technology.

Third, they should understand the links between scientific research, engineering development and commercial adaptation and implementation and understand, also, that there are barriers and uncertainties in translating scientific knowledge into economic and social benefits.

Fourth, they should understand fundamental concepts of probability and uncertainty so that they can grasp some of the complexities of the statistical data on which important public-policy decisions such as risk assessment and risk management are based.

Finally, they should understand some of the tradeoffs which must be made between differing and often conflicting scientific, technological and public-policy goals.

Generally, I would agree with Dr. Knapp's suggestions. In effect he has combined the insights offered by STS studies and those I have just separately outlined in terms of scientific and technological literacy.

Ideally, I believe, mathematics, science, technology/engineering, and STS-type courses should flow naturally from one into another, building on previously acquired skills, so that a student can enter more deeply into the material of each successive course area. For example, a mathematics course should not only satisfy mathematics skills requirements, it should also describe the relationships being "modelled" quantitatively in such a way as to provide a foundation for the scientific and technical material that will be encountered in subsequent science and technology or engineering courses. Similarly, the science and engineering courses, if they utilize appropriate materials, will facilitate entering into a more sophisticated analysis in STS courses for science- and technology-related social issues than is currently the case.

In the end, it is precisely this kind of integrated understanding of science and technology that I would argue enhances an undergraduate liberal arts education and precisely that which can, at most, be reasonably expected of students who do not have the inclination to become scientific or technically-oriented professionals. When all is

said and done, no matter how much technology or engineering the student was exposed to, I would still not drive my car across a bridge designed by a Shakespeare major.

Now, let me turn briefly to a description of three programs or sets of courses that I believe accomplish in most ways the kinds of objectives I have just outlined. At my own institution, in addition to the forty or so STS courses that we have been offering for over a decade now, we have also developed under NSF funding a set of courses in technology and applied science aimed primarily at students not majoring in those areas. In your packet you will find descriptive materials on each of those courses, so I won't go into great detail here but rather will just allude to those courses. Included in the project were:

Chemistry for the Consumer (Ned Heindel, Chemistry Department); The Regulation of Public Safety (Alan Pense, Department of Metallurgy and Materials Engineering); The Factory of the Future (Mikell Groover, Industrial Engineering); Tall Buildings and Urban Design (lynn Beedle, Civil Engineering); Computer Modelling of Our World (William Schiesser, Chemical Engineering): and Mineral Deposits, Economics and World Politics (Charles Sclar, Geological Sciences). Each of these courses attempts to motivate the learning of scientific, mathematical, and engineering materials by disclosing their embeddedness in pressing contemporary issues. The technical material is taught, not skirted. The instructor shows how the decision-making, from which the impact of science and technology on society directly flows, is pervaded by knowledge-bases in science and engineering, knowledge-bases that in turn incorporate mathematics in characteristic ways. Without understanding relevant subsets of those knowledge-bases, a person cannot make informed decisions at the level of anticipated social impact, whether the particular case involves the installation of a municipal natural gas

storage tank, the release for marketing of a new drug, tax incentives for manufacturing-plant modernization, or building a high-rise office building.

A seventh, gateway course, Introduction to Technology, is intended to serve as an introduction to engineering as a problem-solving discipline --linked, on the one hand, to applications of scientific research and, on the other, to more parochial economic, political, and social interests in those applications. While the syllabus pivots about a model of engineering which clearly identifies engineering as an element in a wider system of action in which economic and political motives play formidable roles, a special effort is made to distinguish engineering and physical science. In practice, the two overlap extensively; but in principle they are distinct, and this distinction is central to an appreciation of the social ties of engineering. I should note as an aside that although we initially intended that this course be closed to engineering majors, we changed our plan as the syllabus increasingly centered on a model of engineering which was the basis for exploring the non-technical factors that shape the practice of engineering in the "real world". Engineering students discovered that the course provided a treatment of engineering which was of direct personal interest and available nowhere else in their curricula.

As I mentioned before, ideally mathematics, science, technology, and STS courses should build upon each other and flow naturally one to the next. Two other programs reflect this approach quite nicely. At Syracuse University in the College of Arts and Science where students must take a four-course cluster in the sciences, they were able to design and implement a comprehensive integrated series of courses with three major components:

1) Introduction to scientific literacy - a two-semester introductory course in either biology, chemistry, geology, or physics involving a laboratory;

2) Introduction to technological literacy -- a one semester course involving lectures on concepts of engineering with an accompanying microcomputer-based laboratory component plus specific applications of technology and applied science drawn from the field of science taken by the student; and

3) A course focused on understanding the impact of science and technology on society. In this course each class divides into small discussion sections on particular socio-technical problems relevant to the particular field of science on which they have chosen to focus.

The third course in the sequence, the introduction to technological literacy, deserves some special mention. The first part of the course, entitled The Engineering Approach, contains three major components. The components include:

1. Description of selected major engineering developments.
    A. Computers and Communications.
    B. Structures and Dynamic Machinery.
    C. Energy Conversion.
    D. New Materials-Electronic, Structural and Chemical.
    E. Instrumentation and Measurement.
2. Principles of Engineering Design.
    A. Systems Modeling.
    B. Optimization, Trade-Offs and Decision Making.
    C. Feedback and Stability.
    D. Energy and Signal Conversion.
    E. Instrumentation and Measurment in the Design Process.
    F. Design Decisions and Materials Availability.

3. Issues of Problem Definition and Complexity.

   A. Quantifiable and Nonquantifiable Parameters.

   B. Designing Against Large Number of Interacting Variables and Conflicting Constraints.

   C. Examples from Mass Transportation, Nuclear Energy, Health Service Industries, and Resource Allocation.

   D. The Element of Cost.

In the latter part of the course, students break into individual sections to examine technical applications related to the particular scientific area on which they are focusing. The teaching mode includes lectures and a computer-based laboratory with games and assignments that illustrate the basic engineering themes.

At Polytechnic Institute of New York a slightly different approach is being taken. Although primarily a technically-oriented institution, Polytechnic does have a number of liberal arts majors. These students are required to take a core curriculum based "on the idea that a well-educated liberal arts undergraduate should be exposed to the man-made, in both its technological and traditional forms." The core consists of forty-eight credit hours and is required of all humanities, journalism and social science majors. The core amounts to about 2/5's of the 126 total hours required for graduation. The Freshman core consists of a year-long sequence, "The World of Mathematics and Computers: (8 credits), a three-credit course "Technology and Society in Historical Perspective" and a physical science course with laboratory called "The Physical World" (4 credits). The Sophomore core continues with two more science-based courses, "The Biological World" and "The Behavorial World", each with a laboratory and carrying 4 credits apiece. During the second semester of the Sophomore year, the student also takes "Ethics and technology" (3 credits), which is designed to examine some

of "The basic ethical theories of human action and how these relate to technological making and using." The Junior year core continues with a series of four specific, STS-type courses, each of which is designed to explore in some depth a particular facet of the general relationship between science, technology and society. The courses include: Materials and Social Issues; Machines: Extensions of Man; Information, Communication, and Society; and Energy Technology and Social Issues (3 credits each). Finally, in the Senior year the student is asked to draw all this material together and to demonstrate a connected and comprehensive understanding of it. The first semester includes a course, appropriately entitled The Making of Connections (3 credits), which is intended to draw out the basic issues and general relationships introduced by the previous courses. Topics include the relationship between machines and human nature, relationships between freedom and the individual in a technological society, and relationships between probable futures and alternative social policies in light of rapid scientific and technological change. In addition, the student is required to do an individualized, year-long senior thesis project culminating in an extensive paper. The courses ask students to display both comprehensive general STS understanding and more detailed understanding of a particular issue in the senior thesis project.

Ultimately, the key to the success of all these courses and programs lies in their recognition of the necessity of integrating science and technology with their societal context. The starting point that informs all our Lehigh courses and, I suspect, most of the other good courses that I am familiar with is a conceptualization of technology as a social process, a conceptualization that distinguishes the artifacts and processes that embody the work of the engineer within the broader complex of social processes that shape and define that work

by providing engineers with their problems and at the same time by setting many of the parameters within which the engineer must solve those problems.

Let me suggest that it is not enough merely to teach liberal arts students the same mathematics, the same science, or the same engineering materials that are taught to majors in those fields. Watered down or gussied up, these materials will fail to make an impression if the teaching of them does not recognize and make explicit the complex social process in which the science, the engineering, and the mathematics are woven into a whole cloth.

We need a holistic understanding of what we mean by the "literacy" we are trying to achieve. The mathematics, the science and the technology, yes, even the computer, should be seen as elements within a wider intellectual and social framework. Educational institutions considering new courses in this area need to articulate the objectives of those courses and, in the case of existing distribution requirement courses, will likely have to reconceive their goals. Mathematics, computer, science, and technology literacy courses should be designed to meet the educational needs of liberal arts students, and should not consist of introductory instructional materials suitable only for majors in those fields.

The educational significance of this kind of "literacy" I have described is vital, serving as it does to illuminate fundamental dimensions of our humanity. These dimensions are no less expressive of what it means to be human than are literature, philosophy, art, religion, or history. To be ignorant of mathematics, science, or engineering is to be ignorant of some of Mankind's greatest achievements as well as some of Mankind's greatest failures. That this is true of the other humanities as well, suggests that the importance of

mathematical, scientific, or technical literacy should be on a par with literacy in art, music, poetry, literature, history et cetera, neither higher, nor lower.

Although much of this has been recognized for some time, we have not always sought for our liberal arts students what we should have in the way of science and mathematics education, letting instead a minimal number of introductory courses designed for majors fulfill an arbitrary and numerically defined requirement. Beyond this, few if any schools, until recently have required their liberal arts students to learn about technology and engineering.

Assuming, then, that a case has been made for the educational validity of science and technology literacy courses, what can be said in summary about the direction which such courses ought to take? Courses designed to fulfill requirements for liberal arts students in mathematics, the sciences, computers, engineering and technology need to be designed from the outset with the understanding that the motivations and conceptual orientation of arts students will be radically different from those of majors in these fields. As I have suggested, the courses will need to be structured around educational goals that draw their value from enriching the individual student's personal encounter with his/her world rather than on instructional goals of the sort that make obvious good sense for students planning to major in that field. The worst case would be to offer to liberal arts students elementary versions of instructionally-based courses, for such courses are neither intrinsically challenging nor useful to such students. A plausible approach would appear to be one that aimed at communicating an appreciation of the discipline being treated as: a distinctive problem solving discipline; the presentation of current concepts and methodologies in that discipline; and a description and at least a

qualitative analysis of the discipline's current theoretical models. Mathematics courses for liberal arts students should be taught with a view to subsequent science and engineering or technology courses that they will have to take, and an effort must be made to articulate qualitatively the relationships being modelled by equations and functions.

All of this, in turn, should point toward a deeper and more comprehensive understanding by the student or the complex social context within which scientific and technological activities find their place. This context can be explored more closely in STS types of courses which because of this lack of a well-developed base in mathematics, science, and engineering now seem, and often are, superficial. Such an approach takes time, effort, and money. It also takes special administrative support to provide the environment necessary for faculty to explore new approaches to designing the courses required. Obviously, the job will not be easy, but if it is worth doing then this (or something like it) would appear to be the only way worth doing it. Furthermore, the most likely alternative, given the vested interests emerging on behalf of doing <u>something</u> with respect to science and technology literacy, is that a lot of time, effort, and money will be spent anyway, and the outcome will be no more impressive than the lasting impact of the post-Sputnik renovations which, had they <u>been</u> appropriately designed for a basic understanding of mathematics and physical science might well have obviated the need for promoting science and technology literacy efforts today.

JOURNALS

Science, Technology and Human Values ($48.00)

John Wiley & Sons
605 Third Avenue
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National Academy of Sciences
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Bulletin of Science, Technology and Society ($30.00)

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Department of Sociology
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Technology and Society ($29.50)

Institute of Electrical and Electronics Engineers
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The Weaver (CUTHA) (No Charge)

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Society for Philosophy and Technology Newsletter ($5.00 - Newsletter; $25.00 includes annual volume of Research in Philosophy & Technology.

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Energy and Education ($9.00)
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Science, Technology and Society Curriculum Development Newsletter ($6.00)

STS Program
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SCIENTISM AND THE NEW LIBERAL ARTS

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(Presentation propared for a workshop on Science, Technology and the Undergraduate Curriculum, State University of Arts and Science, Potsdam. November 9-10, 1984)

The question of this session of our conference, "where do we go from here?", presupposes some priorities, and the subject of this conference, "the new liberal arts", assumes something new and improved. I want to examine briefly both these notions. I want to center my comments around the notion of "scientism", that David Edge and Iain Cameron[1] define as follows:

> Scientism is present where people draw on widely shared images and notions about the scientific community and its beliefs and practices in order to add weight to arguments which they are advancing, or to practices which they are promoting, or to values and policies whose adoption they are advocating.

But scientism is, I think, more than that; it is or is becoming the dominant western ethos and world view. I want to propose that one of our first tasks in the "new liberal arts" is to examine this ethos, discover its origins, and acquaint people with the dangers inherent in it.

More specifically, there are three implications of scientism that need to be explored; the first involves its implications for public policy, the second its implications for our system of values, and third, the relationship between science and technology inherent in the idea of the new liberal arts.

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[1] Scientific Images and Their Social Uses: An Introduction to the Concept of Scientism. Iain Cameron and David Edge, Butterworths, 1979.

The issue of the role of science in public policy is, of course, an old one and probably can be traced back to Plato's idea of the philosopher king. There are those who argue that scientists are more capable than politicians, lawyers and others because scientists influence and guide by facts and relationships, while other guide by self-interest and rhetoric. This view of science and the scientist is exemplified in this quote by Jacob Bronowski[2] when he says:

> Scientists do not make wild claims, they do not cheat, they do not try to persuade at any cost, they appeal neither to prejudice not to authority, they are often frank about their ignorance, their disputes are fairly decorous, they do not confuse what is being argued with race, sex, or politics.

Others, such as Michael Polanyi, take great exception to the idea of the scientist as policy maker, not because scientists are less pure and unspoiled, but because of a fear that the alleged purity of science is vulnerable to the contaminating influences of politics and social interests. Yet, the assumption made by people like Bronowski and Polanyi, that scientists are somehow more "rational" and less subject to social and political influences, is a largely unexplored one, and needs our critical examination.

The second assumption implicit in scientism is that our value system, our ethics, and the definition of "good" can be derived from sciences. Robert Merton, for example, sees scientists as egalitarian, tolerant, open-minded, emotionally detached, and supremely rational.

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[2] Science and Human Values. Jacob Bronowski. Harmondsworth, 1964.

There is, in fact, almost a utopian quality to some descriptions of science; consequently there have been frequent attempts to derive ethical systems from the content of science. The logic of the argument goes something like this:

> Whatever is natural (that is in nature) is good and true
> Science reveals and discovers the natural (natural law)
> Therefore: science is capable of revealing the good and true.

Manifestations of this logic have popped up repeatedly. Darwin's theory of evolution has given rise to numerous ethical theories; thus as C. H. Waddington[3] put it:

> Science can provide a secure basis for ethics by discovering and exhibiting a reality to be an evolutionary process tending in a certain direction, action in conformity to which is taken as right conduct.

More recently, ecological theory has given us an ethic in which actions that conform to an ecological process are taken as right conduct. As Aldo Leopold[4] put it:

> A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

Ecological ethics reflects the yearning for a 'whole', integrated and conflict-free society symbolized in the image of a pure and harmonious nature. This brand of ecological ethics was central to the German youth movements of the 20's and is used today as a justification for centralized control in society.

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[3] Quoted from Scientific Images and Their Social Use. Iain Cameron and David Edge, Buttersworth. 1979

[4] Quoted from Scientific Images and Their Social Use. Iain Cameron and David Edge, Buttersworth. 1979

The third assumption explicit in scientism is that science is responsible for developing theory, while technology develops practical applications for the theory. This myth of the priority of science is a deep-rooted one. The problem is that the myth camouflages the extent to which science is dependent on technology for its development. I suspect that an examination of the development of such new sciences as meteorology, high energy physics and radio-astronomy will quickly demonstrate the crucial role of technology in the development of scientific theory.

These, then, are at least three issues that deserve immediate attention: the role of the scientist in public policy, the role of science in defining our values, what is right and proper, good and true, and the relationship between science and technology. The question is what do these issues and the question of scientism have to do with the new liberal arts?

The Sloan Report on the new liberal arts defines it as:

> An attempt to encourage educators to recognize that quantitative reasoning and technology deserve a special place in todays undergraduate curriculum.

Further on it says that,

> Ideally the undergraduate curriculum, as it is envisioned in the new liberal arts program, would be suffused with quantitative and technological study.

It is necessary that liberal arts students know about science and technology; The Double Helix should be on the same list of required reading as Shakespeare and Freud. But, as Jerry Gravander noted, it is equally as important that issues, such as the ones I mentioned above, be included in the curriculum of science and engineering students. They, as well as liberal arts students, need to be aware of the dangers inherent in scientism. What I want to propose is an expanded view of

the new liberal arts. I want to propose that programs such as the Science, Technology and Society Program at Lehigh and the Science Studies Program at the University of Edinburgh be examined as models of the new liberal arts. There is, of course, a certain irony in using these programs as models for the new liberal arts, as there is in Dr. Cutcliffe being our guest speaker; both programs, the one at Lehigh and the one in Edinburgh, are programs designed to bring a liberal arts perspective to science and engineering students, rather than science and technology to liberal arts students.

The science studies unit at Edinburgh consists of four people: David Edge, an Astronomer and ex-head of science production at BBC, and extensive writer on the relationship between science, technology and values; Barry Barnes, sociologist with a biology background whose specialty is the sociology of knowledge; David Bloor, philosopher, with a background in mathematics and a specialty in the philosophy of science; and Steven Shapin, an historian of science with a biology background. What I think the Edinburgh group exemplifies is what I think is needed to explore the issues I've outlined; it represents a combination of specialties whose interaction has broken down discipline barriers and has allowed a fresh perspective on issues of science, technology and values. This is, I believe, the major theme that has emerged at this conference; the new liberal arts should represent a fresh coalition of the old liberal arts. And this is required. For example to explore the issue of scientist as policy maker requires, among other things a knowledge of sociology and anthropology: what are, if any, the social interests of scientists and how do they influence their policy recommendations. Historians need to examine the historical role of scientists as policy makers: the history of the role of scientists in eugenics, the role of the scientists in the development

of nuclear power, the role of the scientist in urban policy, especially as it relates to the use of systems theory. Engineers are needed to shed light on the role of technology in development of scientific theory. Examples abound, and I doubt if there is an academic discipline that cannot make a major contribution to the new liberal arts.

The problem is developing curriculum structures that allow and encourage people from different disciplines to work together. We need to develop forums for the kinds of interdisciplinary exchanges that occur in programs such as the STS Program at Lehigh and the Science Studies Program at the University of Edinburgh. When that occurs we will begin to develop the expanded view of the new liberal arts relevant for students in all fields.

"A discussion of the Science in Society course at Potsdam College"

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During the second semester of 1984, the author presented an interdisciplinary course entitled "Science in Society" which focused on the key scientific issues of today.

Since our lives are dominated and influenced daily by numerous aspects of science, it is appropriate that students obtain a broader exposure to dominant scientific issues. Basic to an understanding of how science influences our society is an understanding of the science thought process. This is only possible if one is familiar with basic scientific concepts in addition to the scientific vocabulary. Since the layman often thinks scientists speak in "foreign tongues" they often find difficulty in understanding basic scientific issues. To promote understanding one must learn the basic working vocabulary. Only when this is accomplished is it possible to consider those scientific issues which impact upon society.

The course of Science in Society taught at Potsdam College was based upon presenting to students the basic vocabulary and principles necessary for comprehension and discussion of those scientific topics which influence our lives today. This course was very selective in subject matter in that it was issue-oriented using these topics currently in the news. Following is a brief list of the discussion topics:

1. Techniques of Land use Planning and Environmental Impact Assessment
2. Geological hazards (e.g. earthquakes etc.) and social impact
3. Acid rain and its political ramifications
4. Origin of soils and soil conservation
5. Soils and developing nations
6. Groundwater geology
7. Who owns the water?

8. Genetics and bioethics
9. The greenhouse effect - its social and economic impact
10. Waste disposal - who is responsible for it?
11. Laser technology and our future life-style
12. The history of computer technology
13. Computers in society
14. The future of science education at all levels
15. Nuclear power and its significance regarding the energy power.

Each unit was introduced by a lecture from a visiting science or math professor. The formal presentation consisted of essentially a general survey (or one hour mini-course) of the topic in which all the very basic terms and concepts of the subject were listed and discussed. The next class focused upon the social impact of the scientific idea previously presented. Different formats were used for these sessions. Usually professors from non-science departments, e.g., economics, etc. were invited to participate in front of the class in a round-table discussion centering upon the impact of the topic upon their interest area. Frequently movies or video tapes were used to introduce the topic and class discussion followed. At other times I simply interviewed the visiting professors much in the same manner as in a TV talk show. Students were encouraged in all cases to participate although their role varied from active to passive depending upon the format used. Disciplines represented throughout the semester included all the Sciences, Math, Computer Science, English, Geography, Political Science, History, Philosophy, Engineering, and Science Education.

Students had a textbook for the course but depended more upon material from outside readings on reserve in the library. Grades were based upon written exams, a final term paper, and class participation. Needless to say the latter was difficult to evaluate in terms other than satisfactory or unsatisfactory. The only prerequisite was that a student had one semester of a college science course. Nineteen students enrolled, about half being science majors.

Student evaluation of such a course was positive, stressing mainly the value of such an interdisciplinary approach to their education. Although most of the students were declared majors, they found such a course a refreshing departure from "required major related" courses. And, yet, the majority agreed that Science in Society was an important supplement to their major since it forced them, by virtue of the course format, to make connections where they never had before. In short, they realized the significance of the liberal arts and particularly the value of the interdisciplinary approach in modern problem solving. Many asked for a Science in Society II to be offered.

I share the observations of the students. The idea of such a course does work. However, I do question if the same format could be used for a larger class. Also, to involve every semester representatives from over 10 departments (although most only participated for one period as guest lecturers or panel members) does present a staffing problem. If a group of likeminded capable faculty feel strongly enough about this type of course, such participation certainly would be less a burden since they would do it for "the good of the cause." It has been demonstrated, however, that interdisciplinary courses (be they Science in Society types or other types) should be regarded a valuable part of any Liberal Arts program regardless of how they are presented to the student body.

I personally feel strongly that students today should get as much exposure as possible to a problem solving approach. In attempting to solve problems, they become participants in education and not just consumers of education. However, as the Science in Society course demonstrated, one first must be knowledgable about scientific terms and concepts before attempting to solve problems. In addition, many

problems require an interdisciplinary approach to be used in their solution. This approach requires one to have a broad liberal arts base as a frame of reference.

It is suggested that education today should give students a broad background in the fundamentals of many specific thought processes in addition to showing the role that each thought process plays in today's society. In a typical liberal arts curriculum one gains exposure to the specific thought processes by taking courses in specific disciplines. The student learns, for example, how a chemist, or economist, or philosopher thinks. This exposure is very essential to modern education and thus should be retained in our general distribution requirements (required units of Science, Humanities, and Social Science) for graduation. However, our curriculum should also include capstone interdisciplinary courses (of which Science in Society is only one type of example) which tie the individual disciplines together by focusing on problems of modern society. Only when this is done will students receive a General Education.

The School-Within-the-School Program of The State University College of New York at Potsdam: An Experimental, Interdisciplinary, General Education Core

The 1985-86 program is a twenty semester-hour core curriculum for first-year students. For bureaucratic reasons, it is divided into two-five-credit hour courses per semester - Literature, Politics, and Society in Western Culture, and Science Technology, and Society in Western Culture (see attached syllabi) - that function as a unified ten semester-hour course; hence, students must enroll in both. The two semesters together are designed as a single, year-length program. While students may opt out at the end of the first semester and apply their ten hours to the general education distribution requirement (we seem to run the usual 10-15% attrition rate for such programs), only those who complete both semesters are, in addition to receiving the twenty hours credit, exempted from English composition and have but five more courses to take, including a laboratory science, to complete the present college-wide general education requirement. At Potsdam, this requirement is the common one of thirty-nine semester hours divided among introductory courses in the humanities, social and natural sciences, plus an additional four-hour English composition course.

The S.W.S. program is completely voluntary and most entering Freshmen are apprised by letter of its existence and offered a chance to participate. The present program is designed to be staffed by four faculty per semester, each at nine hours of the normal twelve-hour load (one course per semester is taught in one's home, or other, department) and to accommodate sixty to eighty students at ten semester-hours per.

In the program's nine years of existence, in various forms, we have never had more than fifty-three students volunteer out of a possible yearly pool of about six hundred; despite the advantage of having most former

students willingly testify to its benefits. This Fall, we have forty-three students, but only three faculty. Like everyone else, we had to take our lumps in the annual budget bashing. This is why the Fall semester syllabus below has only three names on it. We were able to temporarily accommodate only because the present faculty were all experienced in the program and willing to pick up themes and subjects not normally expected. If we permanently lose the position, the program will have to be seriously redesigned; so, apprehend the Fall syllabus as designed to be taught by four faculty.

The program is structured to have two faculty drawn from those in the natural sciences with a bent for history and method, or from historians, philosophers, and others with a penchant for, and background in, science and technology. The other two faculty are drawn from those in the humanities and social sciences interested in the forces, ideas, people, events, and artifacts that helped shape the modern world. Participating faculty have to be willing to team-plan and team-teach, i.e., commonly choose course materials and themes, read each other's assignments, attend all the lectures and programs, negotiate final evaluations and those examinations and papers where we have two readers, and, as often as possible, interconnect one's own presentations with others. As with most interdisciplinary programs at this time, it is helpful to be able to draw on relatively senior faculty not overly concerned with the usual departmental rewards and disciplinary approval.

Mostly because of the budgetary strictures of the past decade, the present program developed from a much more ambitious one designed and taught around a thirty semester-hour core staffed by six faculty, and that included projected upper-level interdisciplinary seminars and guided projects. The present program responds to only one, but maybe the most significant, of a number of original missions given the S.W.S.: that is, to try

to develop a general education core that would provide a "common educational experience," a framework, that students could flesh out with, relate to, the rest of their educational experiences. Such a core should seek out the similarities, the common threads woven through the various disciplines and methodologies usually treated separately. The core should confront students with some of the salient intellectual, moral, social, and environmental complexities and debates of our time, and explore some of the paths by which they became central and problematic issues. The program should examine the "hows" and the "whys" as well as the "whats." Hopefully, the experiment would provide a model, or information to develop one, that could be transformed into a college-wide general education core.

Of course, any such general education program would have the goals of fostering analytical thinking, sharpening written and oral communication skills, preparing students for citizenship, and the rest of the "Mom, God, and apple-pie" desiderata that grace the pages of college catalogs. Although these were among our objectives, we never defined the program in terms of them because: (1) Most of us felt they were untestable as general concepts, i.e., one is always in the process of becoming a better writer, speaker, thinker. It is not an either/or situation and skills do not neatly transfer between easy and difficult materials even within the same subject matter, no less across areas. However, where skills can be tested and evaluated, which we do, is in relation to a specific subject matter; hence, the subject matter and not the skills should provide the raison detre for a particular program; (2) Most of the desirable skills and behaviors often advocated to justify general education courses are ones that belong as objectives of most courses across the curriculum and it would be an insult to our colleagues to claim that what makes our, or any other general education course, unique is the attempt to fulfill such objectives.

The program reflected in the syllabi is the most recent atttempt to fulfill our primary mission, and other objectives, within the strictures, staffing, available semester hours, and in light of what we have learned over the past decade planning and teaching various versions. While the people whose names are on the syllabi are directly responsible for the particular content, the syllabi reflect the experience of the twelve other faculty who taught in the program for a year or more, assorted consultants and information sources, and a number of guest lecturers.

Although, for student interest and apparent relevance, we originally wanted a course in the "modern world" which we, like others, defined as predominantly stemming from the Industrial and Democratic revolutions, it soon became obvious that these made sense to students as revolutions only when juxtaposed to some knowledge of the social, political, and technological conditions that preceded them. We thus had to devote a significant portion of the course to the transformation of ideas about ourselves, the natural world, justice, and who should have power and authority, that increasingly took place from the Renaissance and 17th century onward. And since this gradual evolution of a western world-view, of new ways of "seeing" and knowing, was not, nor is, universal but itself a significant, if incomplete, departure from other modes, we had to take a look at what it departed from.

Our real starting point, after a brief look at some of the problems, paradoxes and questions of our own time-necessary for reminding students that our and their main interests are an understanding of the contemporary world that we live and act in - is something we, and others, call the Medieval synthesis. Hopefully without doing too much violation to historical complexity, we attempt to demonstrate a universe far different from ours but some of whose ideas and institutions shape, and exist into, our own time; a world of Ptolemaic cosmology, Aristotelian physics, Thomistic

rational theology, technology, political and economic organization, art, architecture, and literature integrated by "correspondence," and whose ways of knowing were dominated by reference to revelation, authority, tradition, and the collective wisdom of the past.

The Medieval period seems to us a good starting point for a course in western culture since, within a twenty semester-hour boundary, there is little chance to cover classical antecedents. Besides, in many ways the most important effects of classical sources on western culture are better examined as the Middle Ages preserved and perceived them, and in their 12th and 13th Century revival. Starting here also gives us the chance to look at what, for most students, is a completely "foreign" way of organizing and knowing the world; yet, is their direct inheritance. The constricts of time prevent us from the desirable general education goal of exploring a culture other than our own; hence, within our modest program, this Medieval world helps to give some sort of sense of "otherness" as well as provide a defensible starting point for looking at who we are. Since the West came to dominate, in one way or another, most of the known world by the 19th and 20th Centuries, giving the study of western culture primacy needs little defense for a limited program. We think that our program is a minimal starting point that could be expanded backward to the ancient, and even pre-historical worlds; outward to the study of other cultures, eras, and disciplinary specialties, and forward to a conception of possible and probable futures. Since it integrates science and technology with the more usual ideas, politics, and arts approach, it has appeal as an underpinning for the "new liberal arts." As it stands, it would seem to be useful as a primary general eduation and liberal studies core for non-liberal arts institutions, and as a basic framework for those devoting more time to the liberal arts.

Except for a few notes, I think the following syllabi are self-evident. The pedagogical structure consists of a weekly formal lecture of about an hour and a quarter followed by discussion in each of the two courses. The lectures are supposed to set the themes, provide interconnections, and historical background. There are small group discussion sections of an hour and a quarter on Tuesdays and Thursdays; and students take two of these with each course. They are devoted to discussing and explicating the readings and the themes. There is a two hour convocation on Fridays; like the formal lectures, they are attended by everyone.

In the first semester, students are primarily evaluated on the basis of six 3-5 page essays, and two essay examinations for which they are given a range of questions ahead of time. In the second semester, they submit two essays of 4-6 pages each, and spend the rest of the semester learning the process - bibliography, notes, outlines, drafts - that culminates in a small research paper of about 15-20 pages. Again, there are essay mid-term and final examinations. It is this focus on writing, and on oral communication in the seminars, that justifies the exemption of our students from the English composition requirement.

As often as feasible, we select primary texts for the readings rather than take a survey text approach. Despite all of the difficulties, this has the advantages: (1) of focusing attention on the ideas, problems, and concerns of major figures in their historical contexts, promoting an immediacy, a "showing" rather than "telling," and forcing students to be actively engaged instead of passive; (2) of forcing faculty to put together and communicate the larger picture, to explore and integrate areas outside our normal purview. Such an approach gives greater flexibility in the choice of materials and makes it our course rather than one belonging to the anthology maker. The approach has helped us studiously avoid "canning" the program.

Our use of films such as The Road Warrior, and Quest for Fire, etc., might appear to some as anachronisms. They are not gimmicks. They tie in with the constructs of figures like Locke, and Hobbes, and Rousseau and others, who created their hypothetical "states of nature;" or serve as modern artistic expressions of the 17th century implications of "masterless men" and "restless atoms." They help to connect the familiar world of our students with the usually unfamiliar past.

This concludes a rough introduction to the syllabi. Many of the concepts that justify a program like ours need more elaboration than can be given here. I would be glad to send a more detailed extant philosophical defense to anyone requesting it. I am also in the process of revising that piece; a project which I hope to complete by the end of Spring semester.

Robert Keesey, Acting Director
The School-Within-the-School
State University College of New York
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Syllabus For the School Within the School Program
Fall, 1985
L. Lange, R. Keesey, W. Montgomery

This syllabus contains the required text lists, the lecture schedule and reading assignments, the due dates for papers and examinations, and the Friday Convocation programs of both SWS 101, Literature, Politics and Society in Western Culture, 5 credit hours, and SWS 105, Science, Technology and Society in Western Culture, 5 credit hours. The lecture topics and readings set the themes for the Tuesday/Thursday seminars. After a brief examination of some contemporary dilemmas, the Fall semester program basically concentrates on western culture from the late medieval period to the industrial and democratic revolutions.

The Literature and Politics course will focus on some of the major changes in the ways we organize society; changes in our beliefs about who should rule, have the power over resources and people, about what the rights and responsibilities between the individual and the group should be, and about how we should treat one another. We will look at some of the changes in our attitudes toward the natural world, the ways in which we claim to know it, and ideas about its, and our, origin and our place within it.

The Science and Technology portion of the program will focus on the development of western science and technology from the middle ages to the industrial revolution. In covering this broad period, we will not attempt to survey a detailed list of discoveries and inventions; rather, we will examine a number of selected cases to study the process by which new theories and practices emerged. We especially want to look carefully at relations between science and technology and at the ways in which technical developments have related to the economic, social, political, and religious life of medieval and early modern people.

Literature, Politics and Society
Required Texts:

Dante Alighieri, The Inferno
N. Machiavelli, The Prince
Wm. Shakespeare, Henry IV, Part I
T. Hobbes, Leviathan
D. DeFoe, Robinson Crusoe
J. J. Rousseau, Discourses
Voltaire, Candide

Science, Technology and Society
Required Texts:

Harvey, On the Motion of the Heart and Blood
Galileo, Discoveries and Opinions of Galileo
Newton, Newton's Philosophy of Nature
Guerlac, Antoine-Laurent Lavoisier
Pacey, The Maze of Ingenuity
Landes, Revolution in Time

Required Reserve Reading or Handouts

R. Bellah, et al, Habits of the Heart
Wm. Greenleaf, Order and Empiricism
Montesquieu, "The Myth of the Troglodytes"
J. Madison, Federalist Papers, 10 & 51
S. Wolin, Politics and Vision, Chapter 8

Winner, "Do Artifacts Have Politics"
Hughes, "The Order of the Technological World"
Kuhn, "The Essential Tension"
Merton, "Singletons and Multiples"

Schedule

F, August 30, Convocation: Introduction to the Fall, 1985, SWS Program

M, Sept. 2, The Private/Public Distinction: Modern Society and the Individual.
Reading: from Habits of the Heart
W, Sept. 4, The Context of Knowledge.
Readings: Winner, Hughes, Kuhn, Merton
F, Sept. 6, Film: Woody Allen's Zelig

M, Sept. 9, Problems, Paradoxes and Contradictions in Our Time.
Reading: from Habits of the Heart
W, Sept. 11, Technology and Society.
Reading: Pacey, pp. 13-86
F, Sept. 13, T.V. Film: The Day After Trinity

M, Sept. 16, A Medieval Metaphysic.
Reading: Dante, The Inferno
W, Sept. 18, Medieval Astronomy: The Closed World.
Readings: Reserve List, T.B.A.
F, Sept. 20, Planetarium, Prof. Scott McRobbie, Physics.

Monday, Sept. 23, First Paper Due

M, Sept. 23, Decaying Medievalism and the "new" View.
Reading: Greenleaf, pp. 14-57; 157-205
W, Sept. 25, Medieval Technology: Dominating Nature.
Reading: Landes, pp. 1-84
F, Sept. 27, "The Gothic Cathedral," lecture and slides, Prof. Julia Miller, Art Dept.

M, Sept. 30, The Passions and the Interests: the Materials of Statecraft.
Reading: Machiavelli, The Prince
W, Oct. 2, The Copernican Revolution.
Reading: Galileo, pp. 21-58; 175-216
F, Oct. 4, "Leonardo da Vinci," lecture and slides

Monday, Oct. 7, 2nd Paper Due

M, Oct. 7, Private Man/Public Man: The Problems of "Appropriate Action."
Reading: Henry IV, Pt. I
W, Oct. 9, The New Anatomy.
Reading: Harvey, Motion of the Heart and Blood
F, Oct. 11, Film: Henry IV, Pt. I

M, Oct. 14, No Class
W, Oct. 16, The Mechanical Philosophy.
Reading: Newton, pp. 1-40
F, Oct. 18, "From Medieval to Renaissance Art," slides and lecture

Monday, Oct. 21, 3rd Paper Due

M, Oct. 21, The Science of Politics in a World of Passions.
Reading: Hobbes, Leviathan
W, Oct. 23, The Newtonian Synthesis.
Reading: Newton, pp. 41-116

F, Oct. 25, Mid-term Examination

M, Oct. 28, Liberal Man: Resourceful Survivor or Anxious Accumulator?
Readings: Robinson Crusoe; Wolin, from Politics and Vision
W, Oct. 30, Early Modern Technology.
Reading: Pacey, pp. 116-204
F, Nov. 1, Film: The Road Warrior

M, Nov. 4, Alienation and Liberal Man.
Readings: Rousseau, Discourses; Wolin, Cont.
W, Nov. 6, The Organization of Science: Scientific Societies.
Reading: Landes, pp. 85-170
F, Nov. 8, Film: Quest for Fire

Monday, Nov. 11, 4th Paper Due

M, Nov. 11, The Pen as Sword and Bludgeon.
Reading: Voltaire, Candide
W, Nov. 13, The Geography of Life.
Readings: from Linnaeus, Buffon, and A. Von Humboldt, on reserve
F, Nov. 15, Bronowski film on Newton: The Majestic Clockwork

M, Nov. 18, The Mechanics of Politics: Managing Liberal Man.
Reading: Montesquieu, "Myth of the Troglodytes"
W, Nov. 20, The Chemical Revolution.
Reading: Guerlac, Lavoisier
F, Nov. 22, Classical Music

Monday, Nov. 25, Fifth Paper Due

M, Nov. 25, 1776: A Revolution of Realists.
Reading: Madison, Federalist Papers, 10 & 51
W, Nov. 27, VACATION
F, Nov. 29, VACATION

M, Dec. 2, 1776: The Ideology of Capital,
Reading: selections from The Wealth of Nations
W, Dec. 4, The Industrial Revolution.
Reading: Pacey, pp. 204-321
F, Dec. 6, Bronowski film: The Drive for Power

Wednesday, Dec. 11, 6th Paper Due

M, Dec. 9, The French Revolution.
Reading: Declaration of the Rights of Man
W, Dec. 11, The Industrial Revolution.
Reading: Landes, pp. 171-273
F, Dec. 13, French Revolution, T.B.A.

Approximate Percentage Breakdown for Term Grade: papers, 55; exams, 35; class participation, 10.

Syllabus For the School-Within-the-School Program
Spring, 1985 (Spring, 1986 is not completed yet but will be similar)
R. Keesey, L. Lange, W. Montgomery, E. Todd

Literature, Politics and Society
Required Texts:

A. de Tocqueville
Democracy in America
C. Dickens
Hard Times
J. S. Mill
On Liberty
K. Marx
Communist Manifesto
J. Conrad
Heart of Darkness
S. Freud
Civilization and Its Discontents
S. Lewis
It Can't Happen Here
A. Camus
Myth of Sisyphus
P. Lagerkuist
The Dwarf
M. Herr
Dispatches
F. Hirsch
The Social Limits to Growth

Science, Technology and Science
Required Texts:

C. Darwin
On the Origin of Species
A. Einstein
Relativity: The Special & General Theory
S. J. Gould
The Mismeasure of Man
D. Headrick
The Tools of Empire
R. McCormmach
Night Thoughts of a Classical Physicist
S. Zuckerman
Nuclear Illusion & Reality

Required Reserve Reading or Handouts

F. Dostoevsky
"The Grant Inquisitor"
M. Weber
"Bureaucracy"
C. Rosenberg
No Other Gods
O. Mayr
Yankee Enterprise

W. Jan. 16 Introduction
F. Jan. 18 John Berger "Ways of Seeing", 2 films #

M. Jan. 21 The Rise of the Problem of Society
Reading: Tocqueville, selected sections (TBA)
W. Jan. 23 Science and Technology in Early Industrial America
readings on reserve
C. Rosenberg. No Other Gods, pp. 135-53
O. Mayr, Yankee Enterprise, pp. 49-102.
F. Jan. 25 John Berger "Ways of Seeing", 2 films #

M. Jan. 28 Dark Side of the Industrial Revolution
Reading: Dickens, Hard Times
W. Jan. 30 Technology Transfer
Headrick

W. Jan. 30 TOPICS FOR FINAL PAPERS DUE
F. Feb. 1 Shock of the New: Videotape "Landscapes of Pleasure"

M. Feb. 4 The Rise of the Problem of Society, Part II
Reading: Mill, On Liberty
W. Feb. 6 New Modes of Production
Headrick
F. Feb. 8 Shock of the New: "Trouble in Utopia"

M. Feb. 11 The Travails of Liberal Capitalism
Reading: Marx, Communist Manifesto
M. Feb. 11 FIRST PAPER DUE
W. Feb. 13 The Origin of the Origin
Darwin, pp. 71-78; 89-107; 114-42; 155-72
F. Feb. 15 "Darwin's Bulldog" Videotape

M. Feb. 18 no class
W. Feb. 20 Building Darwinism
Darwin, pp. 205-23; 234-43; 257-63; 291-300; 317-25; 336-43; 349-52; 378-92
F. Feb. 22 Bob Washburn "Origins of Modern Music" Lecture
F. Feb. 22 BIBLIOGRAPHY DUE

M. Feb. 25 The Problem of Choice
Reading: Dostoyevsky, "Grand Inquisitor"
W. Feb. 27 Evolution and Man
Gould, pp. 1-112
F. Mar. 1 Metropolis Fritz Lang

M. Mar. 4 Liberalism and the Social Sciences
Reading: Weber, "Bureaucracy"
M. Mar. 4 SECOND PAPER DUE
W. Mar. 6 The Organization of Science
McCormmach
F. Mar. 8 Midterm - humanities

M. Mar. 11 Liberalism and Restraint
Reading: Conrad, Heart of Darkness
W. Mar. 13 The Old Physics
McCormmach
F. Mar. 15 T.B.D.

M. Mar. 18 Liberalism and Repression
Readings: Freud, Civilization and Its Discontents
W. Mar. 20 The New Physics
Einstein
F. Mar. 22 Einstein Videotape (Time/Life)

M. Mar. 25 Totalitarianism and the Phenomenon of Mass Man

		Reading: Lewis, *It Can't Happen Here*
W.	Mar. 27	Mid-Term
F.	Mar. 29	*Missing* Film (videodisc)
M.	Apr. 1	No class (no fooling either)
W.	Apr. 3	No class
F.	Apr. 5	No class
M.	Apr. 8	No class
W.	Apr. 10	Inheritance and Society Gould, pp. 113-92
F.	Apr. 12	T.B.D.
M.	Apr. 15	The End of the Age of Reason Reading: Camus, *Myth of Sisyphus*
W.	Apr. 17	The Physicists War: Engineering the Bomb Reading on Reserve Kevles, *The Physicists*, pp. 267-366
F.	Apr. 19	*Decision to Drop the Bomb*, Film
M.	Apr. 22	Childhood's End Reading: Lagerkvist, *The Dwarf*
W.	Apr. 24	The Limits to Nuclear Weaponry Zuckerman and readings on reserve
W.	Apr. 24	Rough Draft, Final Paper
F.	Apr. 26	T.B.D.
M.	Apr. 29	The Rise and Fall of the American Century Reading: Herr, *Dispatches*
W.	May 1	The Physical Limits to Growth Readings on Reserve and Hirsch
F.	May 3	*Apocalypse Now*, film
M.	May 6	The Swan Song of Hobbesian Man: "I Can't Get No Satisfaction" Reading: Hirsch, *Social Limits to Growth*
W.	May 8	Conclusion Hirsch
W.	May 8	Final Draft, Final Paper
F.	May 10	Monte Python's *The Meaning of Life*, Film